TTCP WPN TP-4 IM Workshop

Reduced Sensitivity RDX Round Robin Program

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26 January 2006

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 JAN 2006	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Reduced Sensitivity RDX Round Robin Program	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **NSWC Indian Head Division**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM202149., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**21**	

Reduced Sensitivity RDX - Background

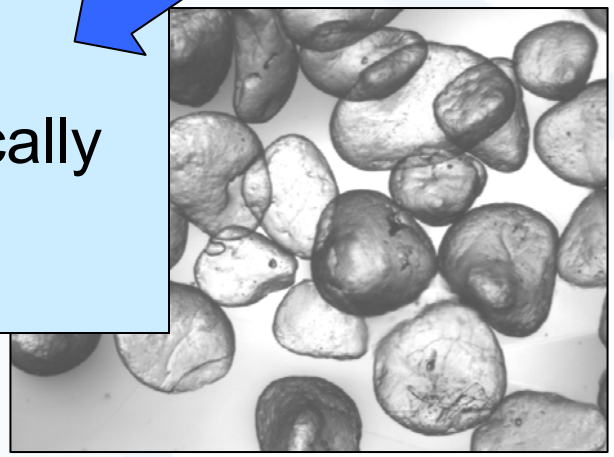
- In the late 1990s Eurenco (an SNPE company) reported an “insensitive” form of RDX (I-RDX®)
  - Woolwich synthesis
  - Employed proprietary recrystallization process – process on industrial scale for >10+ years
  - Produced RDX that displayed reduced sensitivity to shock initiation as measured by Large Scale Gap Test + other tests
- Subsequently, other manufacturers have also reported forms of RDX that exhibit reduced sensitivity to shock
- Of these, ADI and RO also employ the Woolwich process, while Dyno and Eurenco Bofors employ the Bachmann process.

What is Reduced Sensitivity RDX?

"A grade of RDX that exhibits persistent reduced vulnerability to shock initiation in energetic formulations compared to th **Type B RDX**"

This appea with RDX lack of inclusions.

Type B RDX, per STANAG 4022 (Type II per MIL-DTL-398) is made by the acetic anhydride process. It typically contains substantial HMX impurity.



Benefits / Effects of RS-RDX to IM Systems

Increased Critical Diameter
FPX-7 D_c = 50mm
FOXIT D_c = 110-122mm

No reported change in friction or drop-weight impact tests

Improved Sensitivity Properties

SCJ Impact
Calculated to have improved response

Wedge Test
Longer run-to-detonation at a higher threshold

TNO light fragment (N-109)
"n"-RDX Vel_c= 661-69m/s
RS-RDX Vel_c = 1007-42m/s

Shock Sensitivity (Gap test)
130-200% higher pressure at 50% initiation point for PBXs with RS-RDX

SME Heavy fragment
N-109 "n"-RDX Vel_c= 1400m/s
RS-RDX Vel_c = 1900m/s

AC326 SG1 – STANAG Development

Issue

No single crystal level property has been accepted as being able to distinguish RS-RDX from 'normal' RDX

Identify tests & criteria able to distinguish RS-RDX from normal RDX

Ultimate Goal

To develop a new STANAG-4022 to include tests and sentencing criteria to specify a product considered to be RS-RDX.

First Step was the NIMIC/AC-326-SG1 RS-RDX Technical Meeting – Meppen, Germany, Nov 2003.

RS-RDX Round Robin (R^4) Program

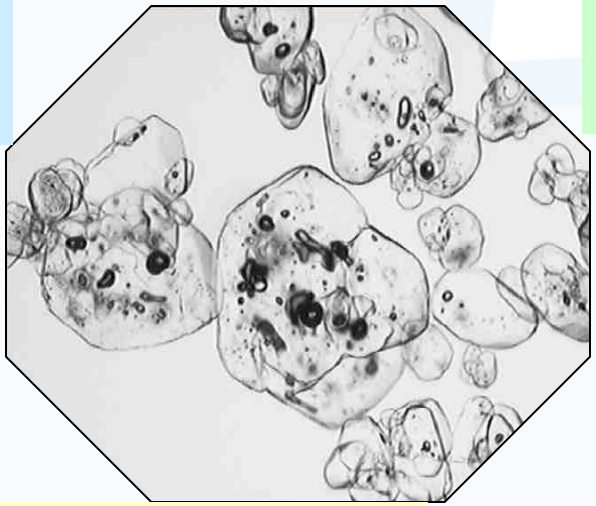
- Initiated from RS-RDX Workshop, Meppen, Germany,11/03
- Supports the development of STANAG 4022 Edition 5
- Using key, simple analytical methods identified at workshop
- Further validation of some procedures included in Edition 4
- Analysis of samples from various producers to verify criteria for identifying RS-RDX
- To be conducted blind – manufacturer of individual samples not known to testing laboratory

Possible Analytical Characterization Methods

Crystals Internal Characteristics

Internal defects
Micro strains
Defects distribution

Microtomography
NQR
Entrapped species meas.
X Ray diffraction
Polarized light microscopy
Optical microscopy
Confocal microscopy



Crystals External Characteristics

Sharp edges presence
Surface defects
Particle shape
Hardness

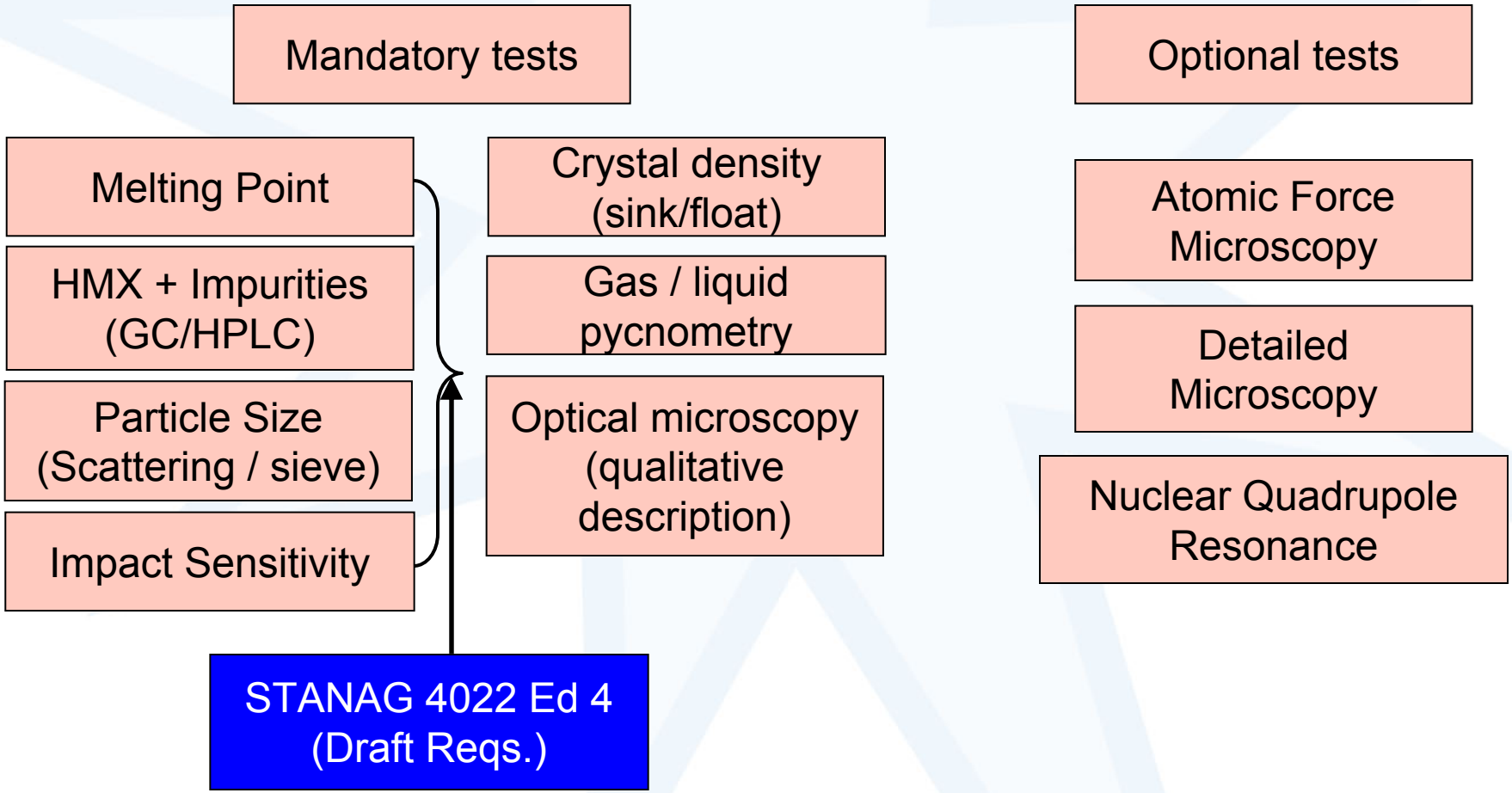
Visual observations
AFM
Surface optical scattering
SEM
Micro indentation

Bulk characteristics

Particle size distribution
Density distribution
Density
Purity

LALLS particle size determination
Sieving
Flotation density determination
Density gradient method.
Gas/liquid Pycnometry
HPLC, GC

R^4 Analytical Tests



R^4 Materials

All samples will be commercially available RDX meeting US MIL-DTL-398D **Class 1** granulation requirement (same requirements specified in STANAG 4022

Class 1 RDX

96 – 100%	< 850 µm
80 – 100%	< 300 µm
30 – 90%	< 150 µm
5 – 45%	<75 µm

Typical median particle size: 200 – 250 µm

Source		Quality					
						RS-RDX	non-RS-RDX
OSI/Holston	Type II	X		X			X
Dyno	Type II	X		X			X
	RS-RDX	X			X	X	
ADI	Grade A		X		X	X	
SME	IRDX		X		X	X	
	MI-RDX		X		X		X
RO/Bridgwater	Type I		X		X	?	

Participating Laboratories

- Australia – DSTO
- Canada – DRDC/Valcartier
- France
  - ETBS
  - ISL
- Germany
  - WIWEB
  - ICT
  - WTD 91
- Italy - Mariperman
- Netherlands – TNO
- Switzerland - Armasuisse
- UK – Dstl through RMCS
- US
  - AFRL/MNME
  - US Army TACOM ARDEC
  - US Army AMRDEC
  - IHDIV/NSWC
  - NAVAIR/Weapons Division

Laboratories in red had not delivered results as of mid-February.

RDX Distribution

- Individual shipments within US to participating labs: arrived late July - early August
- Surface transportation to Canada: arrived
- Shipments via Air Bases to:
  - Germany: arrived Ramstein AFB early September, then distributed to the European labs by mid-September
    - France
    - Germany
    - Italy
    - Netherlands
    - Switzerland
  - UK: arrived at Mildenhall AFB in early September
- Australia: arrived Richmond AFB early October, Edinburgh in November

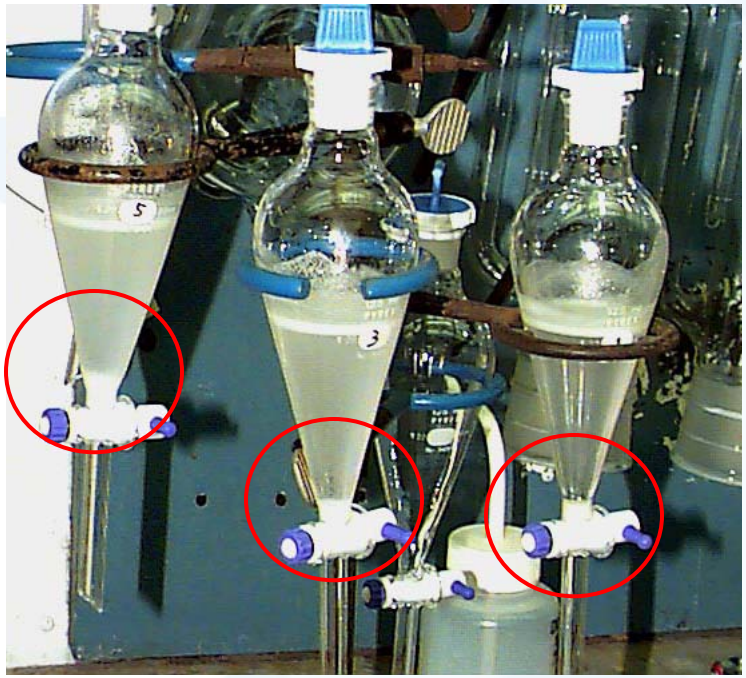
Status

- Testing per Methods Manual has been completed at most laboratories.
  - Switzerland was first to report results (Dec 05), followed by NAVAIR (Jan 06).
  - Others were delivered mid-Jan to mid-Feb.
  - Some data are still outstanding from some labs.
- Analysis of data has begun.

Preliminary Observations

- Some laboratories did not follow the prescribed protocols for conducting the tests.
  - Methodologies differed
  - Some standards not reported
- Flotation density results to date show a great deal of scatter.
- Deficiencies in existing STANAGs have been revealed.

Flotation Density Method



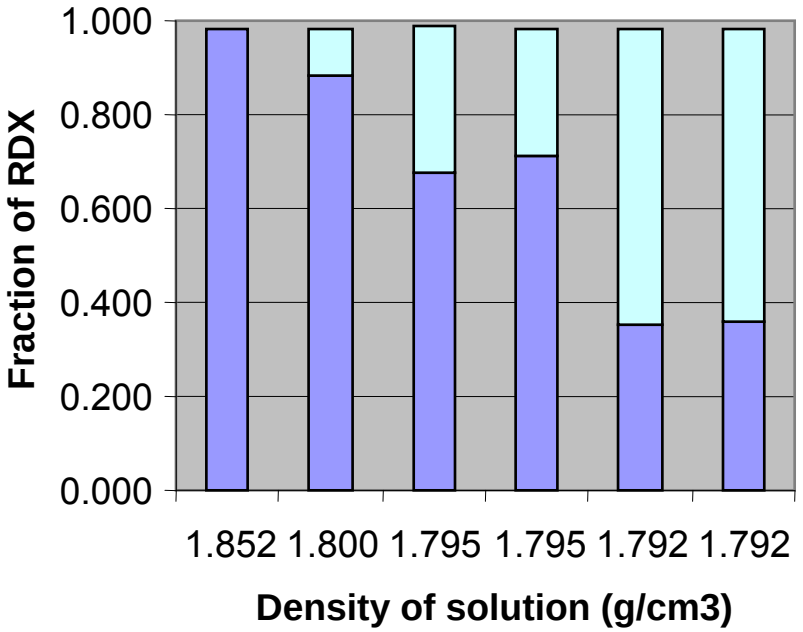
1.795 **1.800** **1.852**

Only HMX and perfect RDX sinks

Only HMX sinks

More flawed RDX crystals float; HMX and better crystals sink

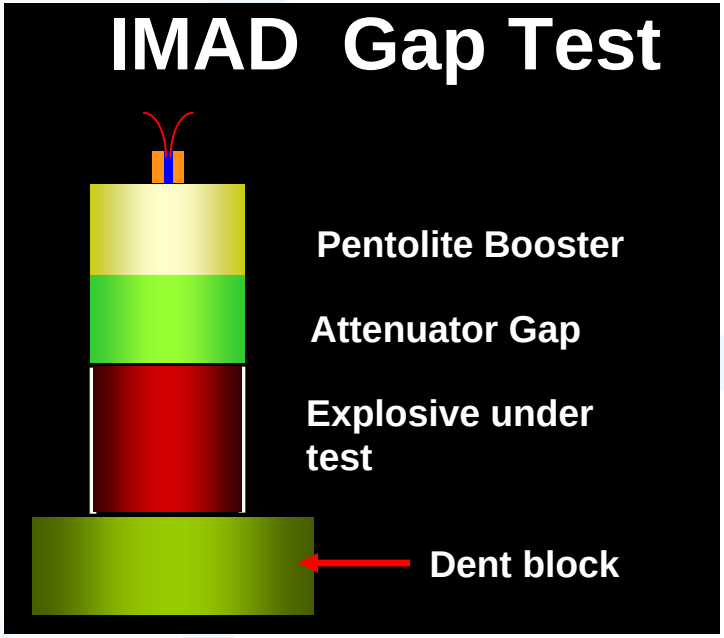
X-ray crystal density of RDX is 1.806 g/cm^3



Recovery of RDX ~ 98.5%

R^4 Shock Sensitivity Study

- **Necessary to link crystal properties with observed sensitivity of a formulation**
- **Formulation:PBXN-109 (RDX / Al / HTPB-based binder)**
- **IMAD Gap Test**
  - **Same booster system as Expanded Large Scale Gap Test (ELSGT)**
  - **Same test charge diameter as ELSGT, but shorter length**
  - **Dent block in place of witness plate**



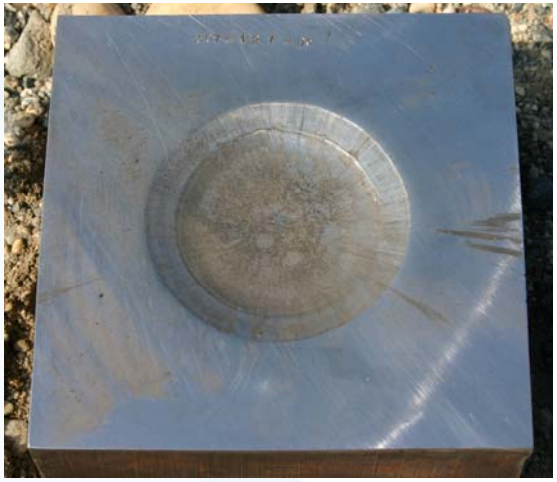
Shock Sensitivity Comparison

- Shock sensitivity comparison with IMADGT completed in Sep 05.
  - Differences observed for different types of RDX.
  - Some additional tests desirable to clarify relationship with existing data.
- LSGT series with all seven lots of RDX will be conducted in March/April 2006 to link back to other reported values.

IMAD GT Dent Blocks

Mix 306
3.00” gap
0.527” dent

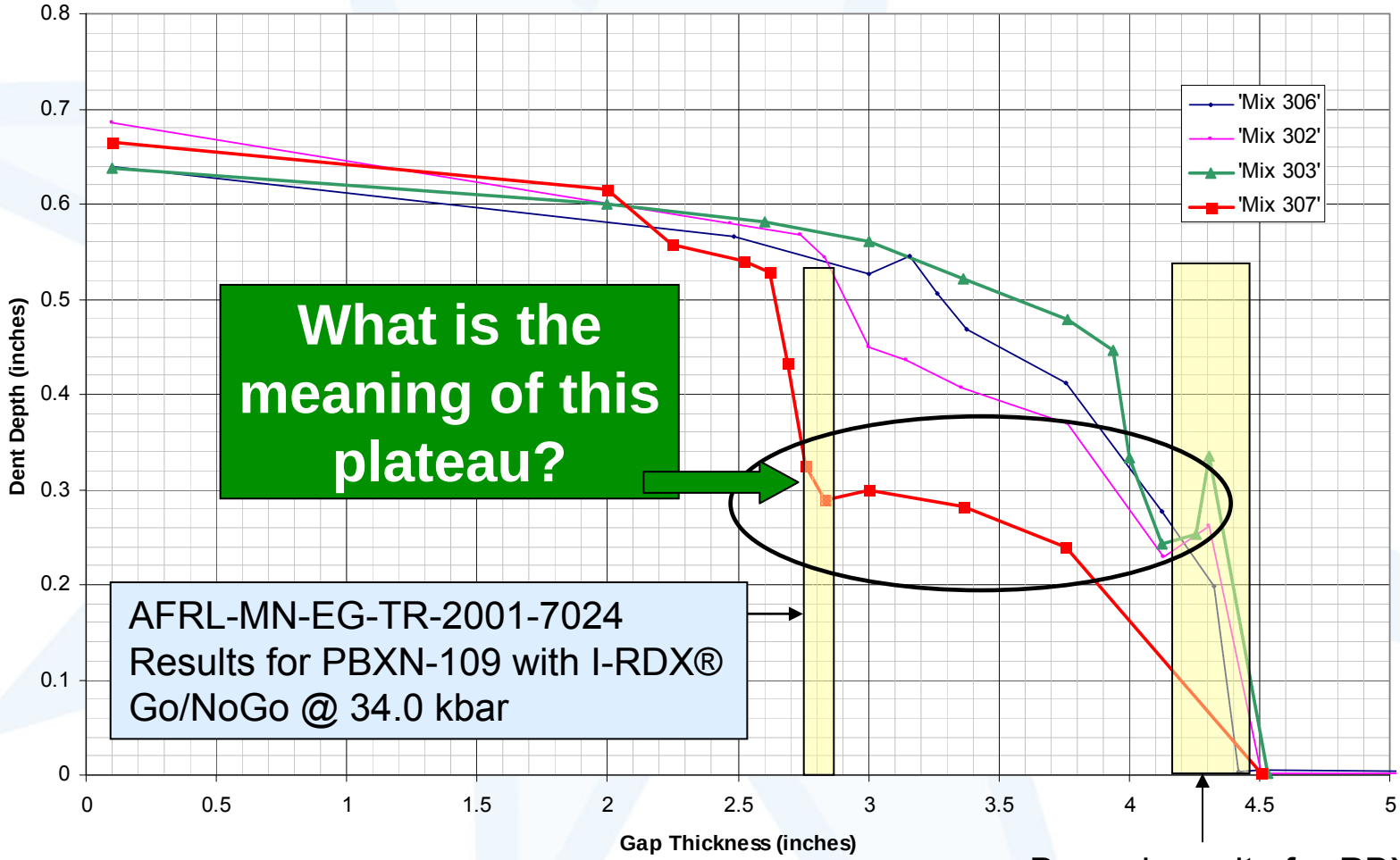
Mix 302
3.004” gap
0.450” dent



Mix 307
3.002” gap
0.299” dent

Both the character of the dent and the dent depth change with different RDX at same gap. The dent block yields more information than the hole in a witness plate.

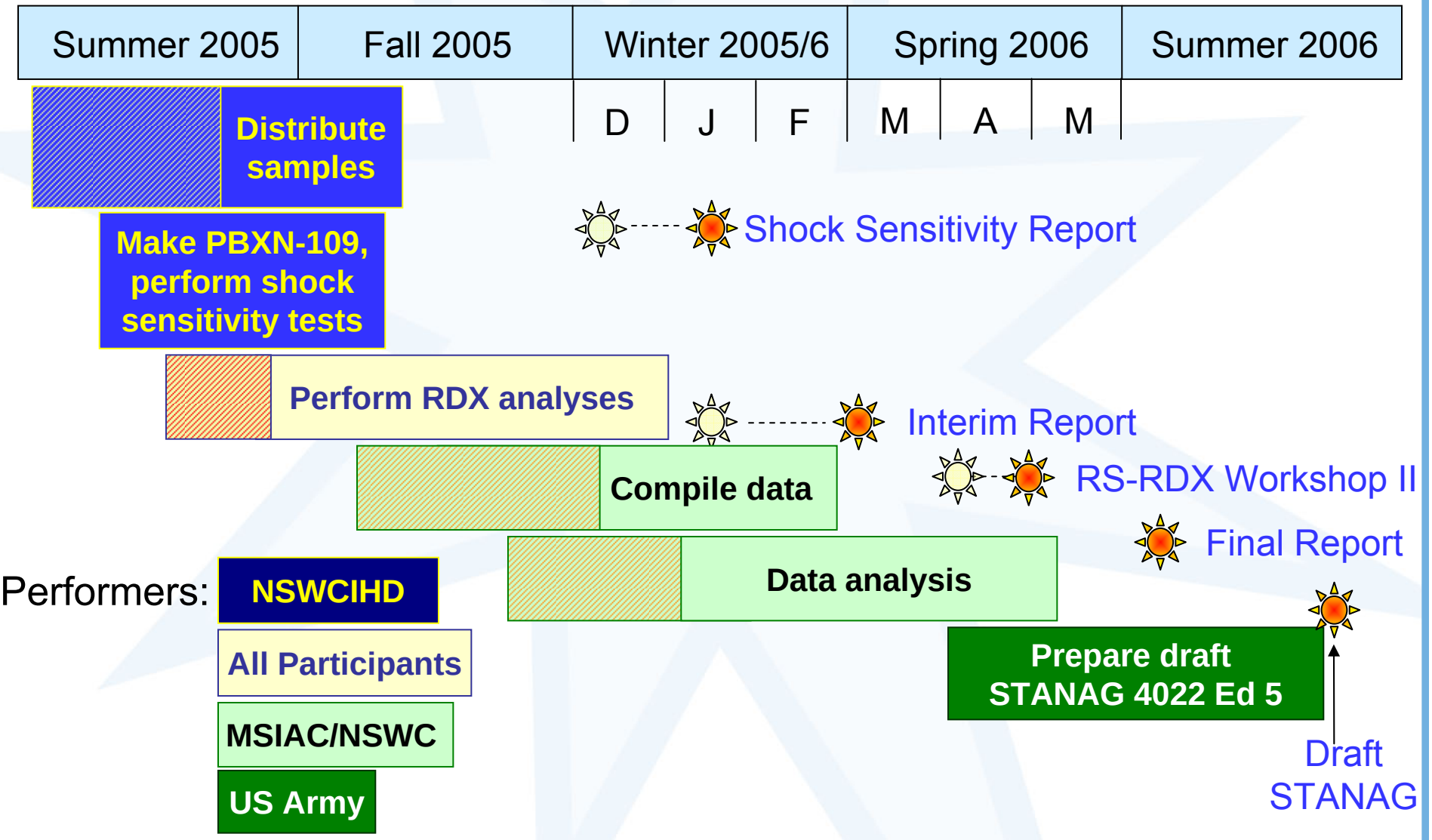
IMADGT Results



RS-RDX Workshop II

- To be held in same location and during same week as IMEMTS
  - Armada House Conference Center, Bristol, UK
  - 24 April 2006
- Attendance by invitation
  - Vendors
  - R^4 participants
  - AC/326 Subgroup 1 representatives
  - Expected attendance: about 50
- Goal:
  - Inform the community of the results of the R^4 program
  - Gather lessons learned to improve methods to be in corporated into STANAG 4022 Edition 5

R^4 Schedule


Summer 2005
Fall 2005
Winter 2005/6
Spring 2006
Summer 2006
D
J
F
M
A
M
Distribute samples
Make PBXN-109, perform shock sensitivity tests
Shock Sensitivity Report
Perform RDX analyses
Interim Report
Compile data
RS-RDX Workshop II
Final Report
Data analysis
Prepare draft STANAG 4022 Ed 5
Draft STANAG
Performers:
NSWCIHD
All Participants
MSIAC/NSWC
US Army

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